Blue Ridge Research and Consulting, LLC

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Naval Aircraft Sound Monitoring Study: Monitoring Plan

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Acronyms and Abbreviations

AICUZ	Air Installations Compatible Use Zones
ANSI	American National Standards Institute
ASA	Acoustical Society of America
ATC	Air Traffic Control
BRRC	Blue Ridge Research and Consulting, LLC
CNEL	Community Noise Equivalent Level
COVID-19	Coronavirus Disease 2019
dB	Decibel
dBA	A-Weighted Decibel
DNL	Day-Night Average Sound Level
DoD	Department of Defense
EIS	Environmental Impact Statement
FAA	Federal Aviation Administration
FCLP	Field Carrier Landing Practice
Fiscal Year	FY
GCA	Ground Controlled Approach
Hz	Hertz
kHz	Kilohertz (1,000 Hz)
IFR	Instrument Flight Rules
L_{01}	1% Percent Time Exceeded Level
L_{10}	10% Percent Time Exceeded Level
L_{50}	50% Percent Time Exceeded Level
L_{90}	90% Percent Time Exceeded Level
L_{99}	99% Percent Time Exceeded Level
L_{Aeq}	A-Weighted Equivalent Sound Level
L_{Amax}	Maximum A-Weighted Sound Level
MOA	Military Operations Area
Navy	Department of the Navy
NAS	Naval Air Station
NASL	Naval Air Station Lemoore
NASWI	Naval Air Station Whidbey Island
NDAA	National Defense Authorization Act
NEPA	National Environmental Policy Act
No.	Number
NOLF	Naval Outlying Landing Fields
ONP	Olympic National Park
OPSEC	Operational Security
OTOB	One-third Octave Band
PII	Personally Identifiable Information
POC	Points of Contact
SEL	Sound Exposure Level
SLM	Sound Level Meter
STD	Standard Deviation
TBD	To Be Determined
VFR	Visual Flight Rules

WAV	Windows Wave Audio Format

1 Overview

1.1 Purpose

This Monitoring Plan describes the processes that will be used to conduct an aircraft sound monitoring study in support of the Navy's requirements under the National Defense Authorization Act (NDAA) for Fiscal Year 2020 (FY20).

The March 2020 *Report to Congress on Real-Time Aircraft Noise Monitoring Plan* prepared by the Navy (hereinafter the *Report to Congress*)[(1)] states that, "The National Defense Authorization Act (NDAA) for Fiscal Year 2020 (FY20) directed the Department of the Navy (Navy) to provide a report to the congressional defense committees not later than December 1, 20201 on the real-time sound monitoring at no fewer than two Navy installations and their outlying landing field on the west coast." The FY20 NDAA Summary Language is provided in Section 1.2.

The two Navy installations selected by the Navy, based on the requirements in the FY20 NDAA, are Naval Air Station Whidbey Island (NASWI) in Washington and Naval Air Station Lemoore (NASL) in California. As stated in the *Report to Congress*: [(1)]

> Both installations lie on the west coast of the United States and host Navy combat coded F/A-18, E/A-18G, or F-35 aircraft. These installations both have noise contours developed using standard Navy noise modeling procedures. The Navy selected NAS Whidbey Island due to interest in the noise landscape in that area and because of its varying topography, which influences aircraft noise propagation. The Navy selected NAS Lemoore as a second location due to its high level of flight activity, flat topography, and surrounding land uses that offer minimal variability and are conducive to consistent outdoor acoustical measurements.

The objectives of the monitoring study include documenting the monitored sound levels, assessing the accuracy of the Department of Defense (DoD) military aircraft noise models via comparisons with the monitored sound levels at NASWI and NASL, and recommending improvements to the noise modeling process and any applicable tools. The assessment of DoD model accuracy will be based on: (1) noise studies previously developed from applicable National Environmental Policy Act (NEPA) documentation and Air Installation Compatible Use Zones (AICUZ) studies, as well as (2) noise scenarios based on the monitored flight operations.

The real-time sound monitoring will involve measuring sound in the vicinity of aircraft flight paths, Naval Outlying Landing Fields (NOLFs), and training areas related to NASWI and NASL. The monitoring will collect operational and acoustic data for high, medium, and low aircraft activity over 7-day quarterly durations, within a 12-month period. For NASL, the monitoring is focused on flight operations at the main airfield since no nearby NOLF is present. The noise monitoring for NASWI will capture tracked and tactical jet operations originating from NASWI that occur in and around Ault Airfield, NOLF Coupeville, and Olympic

1 Due to the coronavirus disease 2019 (COVID-19), the deliverable date for the report to the congressional defense committees will be delayed. However, an interim report will be delivered by December 1, 2020.

National Park (ONP). The operational and acoustic data collected will be sufficient to compare with previously modeled results. The results of the monitoring study will be shared with the public, including all collected data (after operational security [OPSEC] and personally identifiable information [PII] has been removed).

This monitoring plan details the monitoring periods and site locations, the operational and acoustical data collection procedures, and the planned analysis methodology and reporting.

1.2 FY20 NDAA Summary Language

The requirements for the Navy's aircraft sound monitoring study is found in the FY20 NDAA. Section 325 of the FY20 NDAA, entitled, "Real-Time Sound-Monitoring at Navy Installations where Tactical Fighter Aircraft Operate", states the following:[(2)]

> **(a) MONITORING**—The Secretary of the Navy shall conduct real-time sound-monitoring at no fewer than two Navy installations and their associated outlying landing fields on the west coast of the United States where Navy combat coded F/A-18, E/A-18G, or F-35 aircraft are based and operate and noise contours have been developed through noise modeling. Sound monitoring under such study shall be conducted—
>
> (1) during times of high, medium, and low activity over the course of a 12-month period; and
> (2) along and in the vicinity of flight paths used to approach and depart the selected installations and their outlying landing fields.
>
> **(b) PLAN FOR ADDITIONAL MONITORING**—Not later than 90 days after the date of the enactment of this Act, the Secretary of the Navy shall submit to the congressional defense committees a plan for real-time sound monitoring described in subsection (a) in the vicinity of training areas predominantly overflown by tactical fighter aircraft from the selected installations and outlying landing fields, including training areas that consist of real property administered by the Federal Government (including Department of Defense, Department of Interior, and Department of Agriculture), State and Local governments, and privately owned land with the permission of the owner.
>
> **(c) REPORT REQUIRED**—Not later than December 1, 2020, the Secretary of the Navy shall submit to the congressional defense committees a report on the monitoring required under subsection (a). Such report shall include—
>
> (1) the results of such monitoring;
> (2) a comparison of such monitoring and the noise contours previously developed with the analysis and modeling methods previously used;
> (3) an overview of any changes to the analysis and modeling process that have been made or are being considered as a result of the findings of such monitoring; and
> (4) any other matters that the Secretary determines appropriate.

(d) PUBLIC AVAILABILITY OF MONITORING RESULTS—The Secretary shall make the results of the monitoring required under subsection (a) publicly available on a website of the Department of Defense.

2 Monitoring Periods and Rationale

As noted in the *Report to Congress:*

> The Navy does not routinely monitor real-time aircraft noise due to the robust DoD-approved noise-modeling tools and software available to predict aircraft noise contours for long-term planning and assessment. In the absence of a standard DoD or Navy methodology for monitoring aircraft noise, the Navy will rely on guidance outlined in the American National Standards Institute/Acoustical Society of America (ANSI/ASA) S12.9 Part 2: *"Quantities and Procedures for Description and Measurement of Environmental Sound. Part 2: Measurement of Long-term, Wide Area Sound"*

Per ANSI/ASA S12.9 Part 2,[3] temporal sampling will be conducted over four 7-day individual monitoring periods, with one period for each season (winter, spring, summer, fall) at and around each installation (i.e., four 7-day periods at NASWI and four 7-day periods at NASL). Seasonal measurements are utilized to describe the soundscape and its weather variations. An optional fifth period may be monitored if further data collection is deemed necessary. The 7-day continuous duration allows the coverage of weekdays and a weekend as well as evenings and mornings, which will capture periods of high, medium, and low aircraft activity rates. Along with the sound level data, detailed observations will be made throughout the area to identify the primary sound sources received at the monitoring sites.

Below is a conceptual schedule for conducting a monitoring period within each seasonal period:

- Thursday: Travel to Installation
- Friday and Saturday: Deploy equipment at Installation
- Sunday to Saturday: Acoustical and real-time operational data collection at Installation
- Sunday: Demobilization and ship equipment
- Monday: Travel to home office
- Tuesday to Thursday: Initial data review and quality checks (potentially requiring one week)

The operations and acoustical data collection team will consist of two to four people, working eight to ten hours per day. While back-to-back monitoring at both installations was the original goal, scheduling the two airfields back-to-back may not be possible with COVID-19 restrictions varying between the bases.

At this time, the exact dates of the individual monitoring periods will not be established. Coordination with the installation will identify periods of normal or increased operations within each seasonal period. Additionally, for NASWI, the monitoring periods will attempt to align with regular training operations at NOLF Coupeville. The timing for this coordination is expected to be ten days before the monitoring will start.

In addition, a semi-permanent Sound Level Meter (SLM) will be located within ONP. This monitor will continuously collect acoustic data for 365 days because of the relatively low operational tempo of military flight operations above ONP within the Olympic Military Operations Area (MOA).

3 Primary and Alternate Sound Level Meter Sites and Rationale

Per ANSI/ASA S12.9 Part 2,[3] spatial sampling will utilize stratified spatial sampling to capture different portions of the calculated noise exposure contours around the installations.[4],[5] The spatial criteria include noise exposure level, flight operation types, and propagation angle to flight tracks. The sites will be selected in a systematic manner to ensure distribution of sites among the criteria and overall areas around the installations. For the site at ONP, the selection of the site will maximum the measurement of aircraft noise events since the modeled aircraft noise exposure levels are very low.[6] In addition, to the technical criteria, logistical criteria are also included in the final selection. These logistical criteria involve access to site and SLM security.

3.1 SLM Site Selection Criteria

The sound monitoring approach involves the selection of ten to twelve SLM sites per installation. Monitoring sound levels occurring in and around each installation will enable a detailed characterization of the soundscape along with identification of the noise sources. Soundscape characterization uses statistical acoustical metrics derived from SLMs to describe the soundscape and assess noise intrusions, such as noise originating from passing aircraft.

3.1.1 Air Installations

Potential monitoring sites were evaluated based on multiple criteria. Three primary criteria included the range of flight types, propagation angle to flight tracks, and modeled noise exposure levels. The range of flight types include the following:

- Departure
- Straight-In Arrival: Visual Flight Rules (VFR) and Instrument Flight Rules (IFR)
- Overhead Break Arrival
- VFR Patterns: Field Carrier Landing Practice (FCLP) and Touch-and-Go
- Ground Control Approach Pattern (GCA)
- Interfacility (NASWI only)

For the propagation angle, the grouping includes the following angular bands:

- Underneath – within 30° from overhead
- Away – greater than 60° from overhead
- In Between – between 30° and 60° from overhead

For the selected sites, their primary flight type(s) will be either Underneath or Away to focus on different aspects of the acoustic propagation algorithms. Some sites may be within In Between for some flight types, but these flight type(s) are secondary for the comparison.

Prior noise modeling identifies distributions of modeled Day-Night Average Sound Level (DNL) or Community Noise Equivalent Level (CNEL) aircraft operations in the following A-weighted decibel (dBA) bands:

- 50 to 60 dBA DNL

- 60 to 75 dBA DNL
- >75 dBA DNL

The preferred location for most SLMs is within modeled areas in the 60 to 75 dBA DNL band since this band is the primary focus of noise exposure modeling for assessing potential community impacts and land use planning. For NASL, the analysis used the noise model for the selected alternative from the 2014 Environmental Impact Statement (EIS).[4] For NASWI, the analysis used the noise model for the selected alternative (Alt 2A) from the recent 2018 EIS. [5]

In addition to the technical selection criteria, the following logistical criteria parameters are used as supplemental factors for the potential sites:

- Access rights and restrictions
- SLM security
- Other sound sources

Access to a site by the acoustical team is required to deploy and operate the SLM during the monitoring periods. Additionally, the site needs to provide a secure deployment of the SLM and limit potential interference. For the immediate soundscape, aircraft noise should be the dominant sound source at a proposed site, with minimal interference from other sound sources (e.g., road traffic, commercial aircraft, construction activity). Preferred sites need to be readily accessible, away from reflecting surfaces, and reasonably safe from tampering or theft such that the SLMs can be left unattended.

3.1.2 Training Area

As noted above, a semi-permanent SLM also will be located within ONP. The location for this meter needs to be in an area where the most aircraft overflights occur. Potential locations were provided by the NPS based on their previous soundscape monitor efforts. Since the semi-permanent SLM will rely AC power and cellular communications, most of these sites are not accessible for different times of the year because of heavy snowfall and limited cellular coverage. At this time the primary site is the Hoh Rain Forest Visitor Center area and the alternate site is the Nature Bridge section of Barnes Point.

3.2 SLM Sites

3.2.1 Selection Process

Lists of potential SLM sites for each installation have been compiled based on input from local leaders, government representatives, and Federal agencies. These consultations helped identify and determine monitoring locations that are of interest or concern to the community, and that align with the objectives of the modeling assessment. The Navy identified additional locations to ensure spatial and technical criteria coverage. The selected sites were spatially distributed to capture a range of typical flight types and maneuvers, including aircraft arrivals, departures, patterns, inter-facility (e.g., to and from NOLF Coupeville), as well as in the vicinity of primary flight paths to offshore training areas, and as close as logistically possible to modeled flight tracks or overflight areas. For the spatial distribution, the sites also needed to provide a range of expected cumulative noise exposures. These locations were evaluated

initially on the technical criteria to refine the number of potential sites at each installation. This evaluation provided an assessment of the spatial sampling coverage and criteria stratification.

From these lists, the potential sites were narrowed down to approximately 20 sites for each installation. These refined lists included a selection of primary and alternate sites for evaluations during logistics site visits that will occur before monitoring begins. The goal after the logistics site visits is to down-select to 10 to 12 sites per installation. Table 3-1 provides the initially selected sites for NASL, and Table 3-2 provides the initially selected sites for NASWI. In additional, a semi-permanent SLM will be located at ONP based on the evaluation of sites suggested by the NPS.

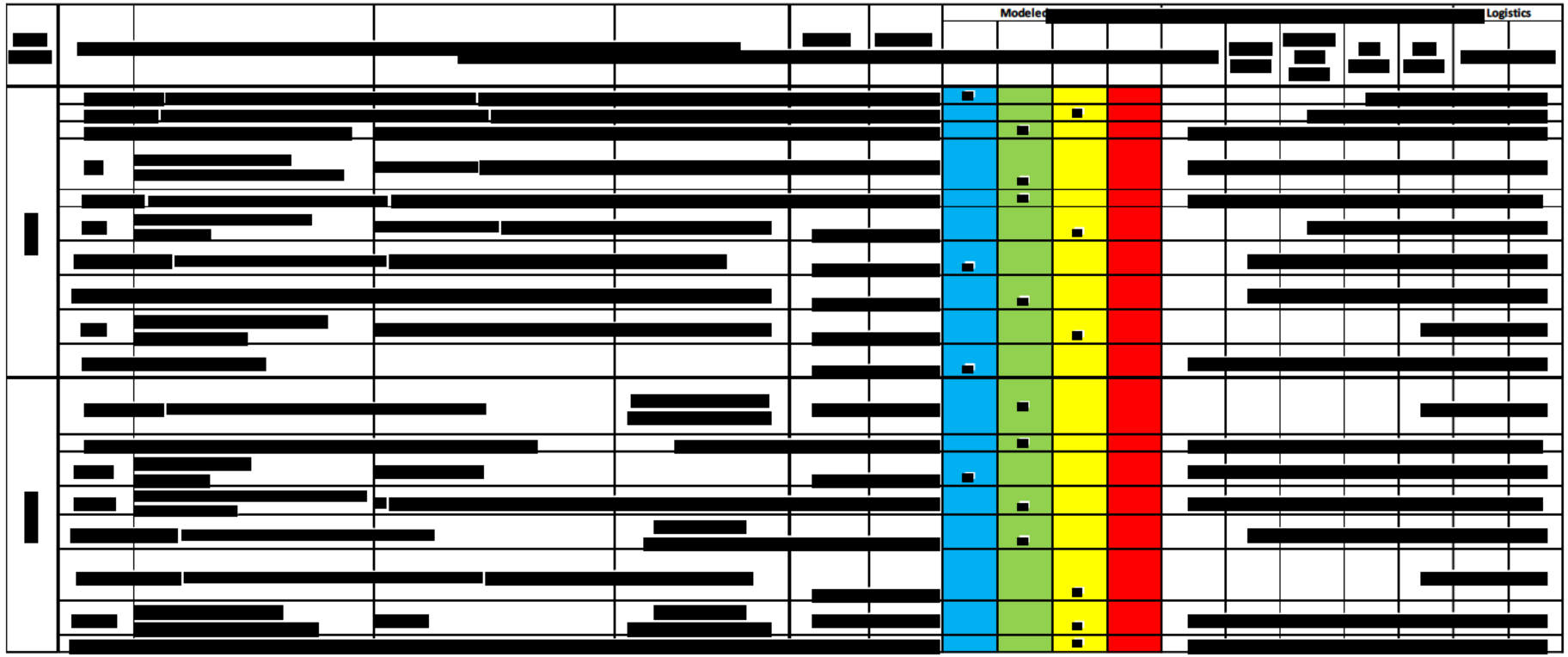
These tables provide the group ranking, location name, noise bands, primary nearby flight operation, and logistics. For the group ranking, "A" indicates a primary site location, and "B" is an alternate site location. The primary ranking was based on suggested sites by local leaders as well as coverage of the technical criteria. The alternate sites met the basic technical criteria and overlap with primary sites. The location name provides a general description and location. The site ID also indicates whether the site was suggested by local leaders (SG), by Navy (T), or by both (B). The noise bands denote where the locations are relative to the calculated noise levels. For NASL, the noise levels are in Community Noise Equivalent Level (CNEL), and for NASWI, the noise levels are in DNL. The primary flight operation indicates the type of flight operation that contributes to the overall noise exposure level. The 'x' indicators show whether the location lies underneath the flight track, away from it, or in between. Lastly, the logistics columns provide an initial assessment of access and security.

As part of the ongoing logistical site visits, the potential sites in Tables 3-1 and 3-2 are being reviewed in person and evaluated based on their access requirements, security from interference, and suitable transit logistics. After the logistical site visits are completed, the SLM locations will be finalized and documented in the updated monitoring plan. For selected sites on private property, access rights will be obtained through the standard Real Estate process. For the final sites, the following information will be identified in this plan: points of contact (POCs), access procedures, and restricted hours (if required).

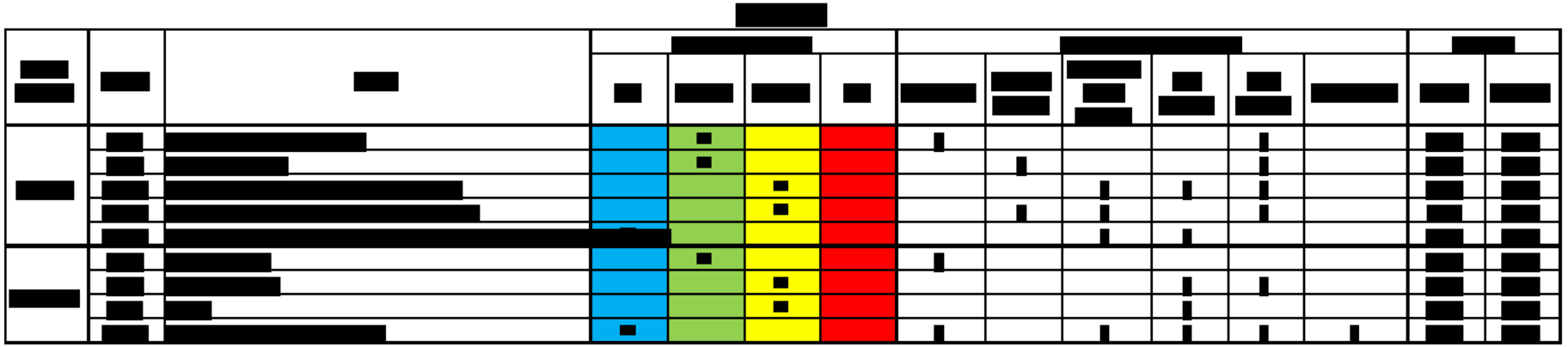
3.2.2 Final SLM Selections

After review of the potential sites, the team worked on obtaining access rights to the primary and alternate SLM sites. During this process a few of the primary sites were replaced with alternate sites because of access restrictions. Table 3-3 and Table 3-4 provide the finalized SLM sites for NASL and NASWI, respectively.

(b) (5)



(b) (5)



Group Ranking	Site ID	Name	Modeled DNL, dBA				Primary Flight Operation						Logistics	
Primary														
Alternate														

Table 3-3. Final SLM Site Selection for NAS Lemoore

Site ID	Location Name	Modeled CNEL, dBA				Primary Flight Operation				
		>75	60 to 75	60 to 50	<50	Departure	VFR/IFR Arrivals	Overhead Break Arrivals	VFR Pattern	GCA Pattern
2_T	Radar site (on base), NASL, CA	✓							x	
3_T	9235 24th Ave, Lemoore, CA			✓		x		x	x	
4_T	22810 S Polk, Riverdale, CA		✓							x
6_T_N2	L & J Vanderham Dairy W Mt Whitney		✓			x				
9_T	Open Skys Ranch (SW corner), 12103 W Elkhorn Ave Riverdale, CA 93656		✓			x	x			x
15_T	S Jameson/W Marmon intersection, Westhaven, CA			✓				x		x
16_T_LF	Capped landfill (on base), NASL, CA	✓					x	x		x
19_T_GC	Phoenix Sunrise Golf Course 14868 18th Ave, Lemoore, CA 93245			✓		x				x
20_B	Child Development Center, West Hill College, Lemoore, CA			✓						x
21_T	Approach end of Rwy 32L	✓					x	x	x	x

Table 3-4. Final SLM Site Selection for NAS Whidbey Island

Ault Field

Site ID	Name	Modeled DNL, dBA				Primary Flight Operation					
		>75	60 to 75	60 to 50	<50	Departure	VFR/IFR Arrivals	Overhead Break Arrivals	VFR Pattern	GCA Pattern	Interfacility
2B_T	Seaplane Base; revised 2B2		✓			x				x	
3A_T	Skagit River Dike		✓				x			x	
4B_SG	Bowman Bay - Deception Pass State Park			✓				x	x	x	
5B_SG	SE Lopez Island at Point Colville - BLM Land			✓			x	x		x	
8B_SG	North Whidbey Parks & Rec (across on NASWI property): Revised 8B2	✓						x	x		
9B_SG	Corner of Banta Rd & Nortz Rd	✓				x		x	x	x	x

NOLF Coupeville

Site ID	Name	Modeled DNL, dBA					
		>75	60 to 75	60 to 50	<50	VFR Pattern	Interfacility
20B_SG	Admirals Cove Alternative: Perry House	✓				x	x
24A_B	NPS Reuble Farm	✓				x	
25B_T	Residence		✓			x	
26B_SG	Reeder Bay LLC parcel	✓				x	x
27A_SG	Town of Coupeville - Water Treatment Plant		✓			x	x
33_SG	Port Townsend Historic Downtown District - City Hall				✓	x	x

3.3 Local Base Support

To assist NASWI and NASL personnel with the requested support for the site selection, the acoustics team provided a checklist for reference:

Support Checklist Site Selection for the Aircraft Noise Monitoring Study

1. **Pre-Monitoring Stage**
   1.1. SLM Site Selection
      - ☐ Identify potential sites
      - ☐ Explore physical access issues, such as seasonal road conditions
      - ☐ Determine easement requirements for any potential private site
      - ☐ Identify access challenges (physical and private)
      - ☐ Determine if SLM can be deployed securely at the potential locations (minimal risk of tampering or theft)
      - ☐ Update the acoustics team regarding potential sites and their access issues
      - ☐ Evaluate position variation options and potential alternative sites

   1.2. Coordinate Site Visit
      - ☐ Assist with creating the agenda
      - ☐ Coordinate schedules and POCs
      - ☐ Provide list of contacts to the acoustics team

2. **Logistics Site Visit**
      - ☐ Ensure POCs are on schedule
      - ☐ Guide the acoustics team to all potential SLM sites
      - ☐ Assist the acoustics team with off-base sites access logistics

3. **Post-Site Visit and Pre-Monitoring**
      - ☐ Support any real estate actions to obtain access permissions
      - ☐ Document access requirements, restrictions, and contacts required for each site
      - ☐ Provide the contact information list to the acoustic team
      - ☐ Review the Monitoring Plan

4. **Individual Monitoring Periods**
      - ☐ Assist SLM set-up at off-base sites (if required)
      - ☐ Coordinate pre-measurement meetings (if required)

5. **Post Monitoring**
      - ☐ Coordinate with real estate to close out off-base access agreements

4 Real-time Operational Data Collection Procedures

4.1 Real-Time Operational Data for Airfields

The monitoring plan includes the development of real-time operational data collection procedures. The procedures include reviewing, modifying, and confirming previously modeled flight profiles and flight tracks, confirming the current local data collection, and ensuring any data gaps are covered by the field observers. Data collection procedures will be finalized during the logistics site visits, including procedures for ground run-up operations, and the source of local weather data.

The real-time operational data collection involves at least two data sources: local Air Traffic Control (ATC) procedures, supplemental tower observers, and field observations. Local ATC procedures involve existing operational data collection conducted in the tower at NASWI.[†] Tower data will be supplemented with data gathered by observers in the tower for Ault Field and by field observers for NOLF Coupeville during each monitoring period.

For the real-time operational data collection, specific data are required to document and identify each operation. These real-time data include the following:

- Aircraft Type
- Squadron Type
- Operation Type (Departure, Arrival, and Patterns)
- Runway Number
- Associated Modeled Flight Track with Variations (Traffic Flow)
- Timestamp
- Exceptions

Static data will also be collected, including the following:

- Aircraft Type
- Location and Heading
- Run-up Engine Powers and Durations
- Variations

4.1.1 Real-time Operational Data Collection Procedures

4.1.1.1 ATC and Supplemental Data

ATC data will include a combination of tower and radar inputs. These inputs will provide the bulk of the required real-time operational data:

- Aircraft and Squadron Type
- Operation
- Runway
- Traffic Flow

[†] NASWI personnel will provide NASL ATC with their current operational data collection procedures.

- Time Stamp

For NASWI, ATC personnel will collect operations data during each monitoring period using existing tower and radar data collection procedures. Monitoring team personnel will collect supplemental operational data that are not included in the existing tower procedures. For example, these supplemental data included break point, abeam distance for patterns, and initial departure turn points. The supplemental data will be collected on a tablet via a computer application developed for this project.[††] During the logistical trip to NASWI, ATC has stated that our team can perform our supplemental operational data collection within the Control Tower.

For NASL, real-time data collect procedures are still under development, and they will align with the NASWI procedures as a combination of existing ATC procedures and supplemental data collection. If an observer is not allowed in Control Tower, then the observer will be located on the ground during the real-time operations monitoring periods. In addition to the type, timing and duration of sound sources, the observers will log flight track and other operational variations or exceptions.

4.1.1.2 Supplemental Operational Data Collection Tool

Figure 4-1 shows an image of the prototype software program used for supplemental operational data collection. The program is based on the noise modeling data from each airfield, and it allows an observer to efficiently document the flight operations at the airfield. Within the upper-left area of the user interface, software users can filter flight tracks according to the runway, aircraft, operation, and operation type. Matching flight tracks are displayed in the large area on the right of the user interface. Once a specific flight track has been selected, the event may be stored in the table within the lower-left area. Additional parameters, such as pattern distance and timestamp, may be documented within the table.

[††] NASWI ATC personnel have tested the software program and determined that they will not use it.

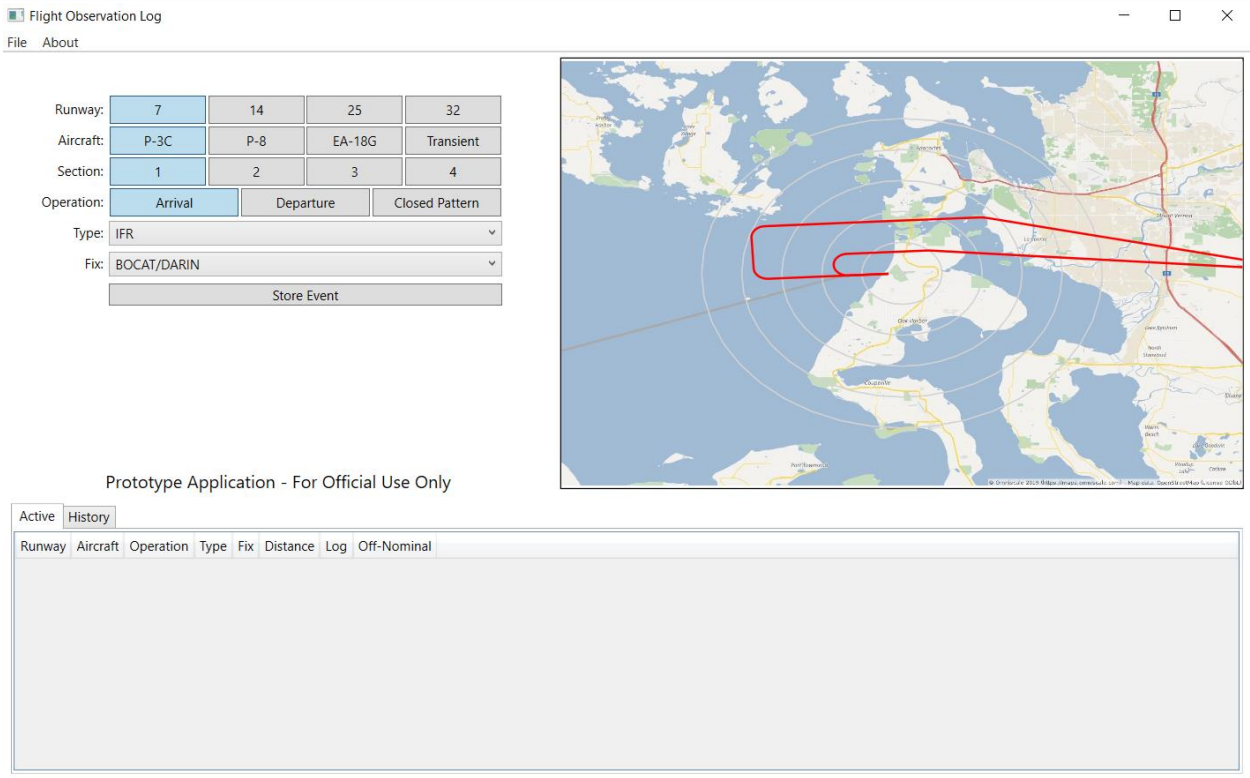


Figure 4-1. Prototype Application for Collecting Operational Data

The program allows for efficient documentation of flight operations to provide cross-correlation of the ATC operational data, as well as the acoustic data.

4.1.2 Daily Coordination with ATC for Planned Operations

During an individual monitoring period, the team will need to consult with ATC and Operations for the planned daily flight schedule before each operational day. This preplanning will assist in the scheduling of field observations for the next day. Operations may change, although this daily preplanning will provide an initial plan for daily acoustical observations.

4.2 Real-Time Operational Data for ONP

The operational data for military activity within the Olympic MOA will include aircraft type, entry time, and exit time. Since the Olympic MOA is controlled by Seattle Center, these data will need to be obtained from the Federal Aviation Administration (FAA) for the entire data collection period, which will be 365 days. The procedures to obtain this dataset will be discussed during the NASWI logistic site visit.

4.3 Data Source POCs

The POCs for specific data types are as follows:

4.3.1 NAS Lemoore

- Real-Time Operational Data: TBD
- Local Weather Data: TBD
- Static Maintenance Data: TBD

- Supplemental Real-Time Operational Data: (b) (6), Leidos
- Acoustical Data: (b) (6), BRRC
- Acoustical Observations: (b) (6), BRRC

4.3.2 NAS Whidbey Island

- Real-Time Operational Data (Ault Field): LCDR (b) (6)
- Real-Time Operational Data (NOLF Coupeville): LCDR (b) (6)
- Real-Time Operational Data (Olympic MOA): TBD
- Local Weather Data: TBD
- Static Maintenance Data: TBD
- Supplemental Real-Time Operational Data: (b) (6), Leidos
- Acoustical Data: (b) (6), BRRC
- Acoustical Observations: (b) (6), BRRC

5 Acoustical Data Collection Procedures

As discussed in Section 3, the sound monitoring will focus on aircraft noise at locations that were selected through the consideration of multiple criteria. Selected locations will balance a mix of monitoring near and away from projected 65 dBA DNL/CNEL noise contours, underneath and away from primary flight tracks, and away from reflecting surfaces and substantial non-aircraft background noise. The semi-permanent SLM will be located in an area that captures the transit flight operations to the Olympic MOA.

The acoustic monitoring methods and procedures employed will follow the technical guidelines developed in ANSI/ASA S12.9 Part 2.[3] The sound monitoring devices will consist of Class 1 SLMs taking measurements in one-second A-weighted equivalent sound levels (L_{Aeq}). Measurement data will include one-third octave band (OTOB) data as well as event-exceedance audio files. Scheduled direct observations will supplement the measured acoustic data at both the regular and semi-permanent sites.

5.1 SLM Equipment

The monitoring equipment deployed will consist of Larson Davis 831C[7] Class I SLMs. The specific SLM models utilized are calibrated data recorders that are capable of high-fidelity sound capture over extended periods and adhere to a range of industry standards, see page A-10 of ref (7). In addition, the pairing of the SLMs with the environmental cases and windscreens ensures reliable sound monitoring against weather variations. The SLM setup will include an omni-directional, random incidence microphone, environmental pre-amplifier, windscreen, mounting tripod, and a securable environmental case. The SLM equipment will be powered by either twelve D-cell batteries or a solar panel attached to a sealed lead acid battery, depending on the desired deployment application[8]. Additionally, optimal placement of microphones will be selected based on local terrain, barriers, and security conditions. The preferred placement of SLM microphones will be placed at a height of five feet above the ground and oriented vertically. This placement represents the assumed receiver location for current aircraft noise models. If a location does have nearby reflective surfaces, the microphone placement will follow the guidance of SAE Aerospace Recommended Practices.[9] This standard recommends that the microphone be elevated to minimize reflections from nearby surfaces.

5.2 SLM Deployment Procedures

The SLMs will be installed and tested for proper operation at the selected monitoring locations, following these set-up procedures:

- Install twelve new D-cell batteries into the SLM;
- Insert desiccants into pre-amplifier holding tube, if applicable;
- Mount microphone/pre-amplifier to tripod;
- Set microphone height given local conditions;
- Confirm SLM program setup;
- Synchronize SLM clock to uniform time;
- Note SLM-reported battery level and memory capacity;
- Calibrate SLM microphone and record calibration tone for 30 seconds;

- Ensure microphone extension cable is secured;
- Secure SLM environmental case with chain and lock;
- Test SLM response to ensure proper functioning;
- Confirm active recording;
- Photograph SLM setup and area; and
- Document time at departure.

These procedures will be encapsulated in the field logs shown in Section 5.6.

5.3 Site Servicing Procedures

During the study, monitoring personnel will visit each site to perform SLM maintenance, site-specific sound observations, and data downloading. This process ensures positive data collection throughout the monitoring period. Monitoring personnel will document each visit, including deployment and removal, within the service field logs. Once the sound level measurements are downloaded from the SLM, the data will be backed up to multiple hard drives, inspected, and reviewed.

5.4 Procedures for Semi-Permanent SLM at ONP

The deployment and operation of the semi-permanent SLM at ONP will follow the same procedures described above for the deployment and servicing of the regular SLMs utilized for this effort. The difference is that this monitor will collect data for an entire 365-day period. This unit will be powered by solar panel and batteries and it will communicate via a cellular modem. These additions require the following additional set up procedures:

- Deploy solar panel (or connect to AC power source);
- Test and confirm cellular connectivity;
- Conduct an initial observation of sounds; and
- Test and confirm data downloading.

This unit will be checked via cellular communication on a daily basis, and data will be downloaded on a weekly schedule.

5.5 Acoustic Observations

During the monitoring period, monitoring personnel will conduct detailed observations to identify the sound sources received at the monitoring locations. These observations will focus on aircraft flight activity, although other sound sources occurring will be recorded. The other sources include static sound sources such as air conditioners and generators as well as transient sound events such as vehicular traffic and farm equipment. Observations will be logged by time (hh:mm:ss) and the applicable L_{Aeq} sound levels will be pulled from the adjacent SLM datafiles using a twenty-second window around the recorded event time ($\pm$ 10 seconds). Then, the loudest one-second L_{Aeq} during the twenty-second window will be used to represent the L_{Amax} of the event. The observed aircraft flight events will be itemized within each observation period. Note, varying quantities of logged observations are likely per monitoring site based on operational activity.

Two to three field observers will perform scheduled observations at (or near) the monitoring sites. The scheduled observation locations will be based on expected runway use and operational tempo for each day, with the duration of daily operations averaging 10 to 12 hours.

5.6 SLM Maintenance Logs

Maintenance logs will be used to document the SLM site visits, including deployment, maintenance, and recovery of the SLMs as well as data downloading. The maintenance log that will be utilized for the monitoring study is shown Figure 5-1 below.

Title: _____
Location: _____
Date: _____
Recorder: _____

Number		SLM Monitoring													SLM Download and Tear Down					
SLM #	Site Name	Replace Battery	Date/Time Sync	Memory & Battery	Confirm Setup	Confirm "Nrml"	Cal Level	Cal Record	Cord Secure	Confirm Record	Ambient LAeq,1s	Non-OBA	Case Locked	Mic Height	Time of Departure	Arrival / LAeq,1s	Memory & Battery	# Pre-Cal OverLd	Cal Record	Time Δ	dL File Name
1		New ☐ Used ☐	Date _____ Time ☐	_____% Free _____v	_____ Time History ☐	☐ +20 dB Gain ☐	Δ_____dB 94 dB ☐ 114 dB ☐	15s ☐ 30s ☐ X.0 dB ☐		☐ Photo ☐	_____ dBA, 1s Whistle ☐			_____ft _____in		Time Date _____ dBA, 1s	_____% Free _____v	_____	15s ☐ 30s ☐ _____ dB	_____ Fast ☐ Slow ☐	
2		New ☐ Used ☐	Date _____ Time ☐	_____% Free _____v	_____ Time History ☐	☐ +20 dB Gain ☐	Δ_____dB 94 dB ☐ 114 dB ☐	15s ☐ 30s ☐ X.0 dB ☐		☐ Photo ☐	_____ dBA, 1s Whistle ☐			_____ft _____in		Time Date _____ dBA, 1s	_____% Free _____v	_____	15s ☐ 30s ☐ _____ dB	_____ Fast ☐ Slow ☐	
3		New ☐ Used ☐	Date _____ Time ☐	_____% Free _____v	_____ Time History ☐	☐ +20 dB Gain ☐	Δ_____dB 94 dB ☐ 114 dB ☐	15s ☐ 30s ☐ X.0 dB ☐		☐ Photo ☐	_____ dBA, 1s Whistle ☐			_____ft _____in		Time Date _____ dBA, 1s	_____% Free _____v	_____	15s ☐ 30s ☐ _____ dB	_____ Fast ☐ Slow ☐	
4		New ☐ Used ☐	Date _____ Time ☐	_____% Free _____v	_____ Time History ☐	☐ +20 dB Gain ☐	Δ_____dB 94 dB ☐ 114 dB ☐	15s ☐ 30s ☐ X.0 dB ☐		☐ Photo ☐	_____ dBA, 1s Whistle ☐			_____ft _____in		Time Date _____ dBA, 1s	_____% Free _____v	_____	15s ☐ 30s ☐ _____ dB	_____ Fast ☐ Slow ☐	
5		New ☐ Used ☐	Date _____ Time ☐	_____% Free _____v	_____ Time History ☐	☐	Δ_____dB 94 dB ☐ 114 dB ☐	15s ☐ 30s ☐ X.0 dB ☐		☐ Photo ☐	_____ dBA, 1s Whistle ☐			_____ft _____in		Time Date _____ dBA, 1s	_____% Free _____v	_____	15s ☐ 30s ☐ _____ dB	_____ Fast ☐ Slow ☐	

Number		Site Details					Notes	
SLM #	Site Name	Serial #: SLM, Mic, & Pre-Amp	Location Description, Address, Lat/Long	Site Photos	Cloud %	Rain	Ambient Description	Comments
1		LD Model SLM No. PreAmp No. Mic No.	Lat _____ Long					Desiccants ☐
2		LD Model SLM No. PreAmp No. Mic No.	Lat _____ Long					Desiccants ☐
3		LD Model SLM No. PreAmp No. Mic No.	Lat _____ Long					Desiccants ☐
4		LD Model SLM No. PreAmp No. Mic No.	Lat _____ Long					Desiccants ☐
5		LD Model SLM No. PreAmp No. Mic No.	Lat _____ Long					Desiccants ☐

Figure 5-1. SLM Maintenance Log Template

5.7 Observer Notes

Field observation notes will be collected to identify the sound sources received at the monitoring locations. These observations will note ambient and transient sound events, sound level on a $L_{Aeq,1s}$ basis (added post-analysis), and the time. Figure 5-2 provides an example of the observation log template.

The purpose of the observation logs is to capture a representative subset of the non-aircraft sources of sound generation in the area, in addition to observed overflights. Sound events from traffic and construction activity may be so numerous that manually logging each observation will be impractical, whereas aircraft events are generally spaced apart in time. Thus, the observation tables will be best used for comparing the relative maximum sound levels produced by the sound event, not the comparative frequency of occurrence. Although the observation logs will not show every passing car, hammer strike, dog bark, strong wind, forklift alarm, leaf blower, etc., all sound sources will be measured by the microphones and will thus be incorporated in the planned hourly sound level variance charts and in the exceedance analysis. More generally, all sound sources in the vicinity of each monitoring site will be measured by the SLMs every second, irrespective of how often the event occurs.

MONITORING SITE 1

Coverage Period(s):
Observed by: Location:

Time	$L_{Aeq,1s}$ dBA	Description

Figure 5-2. Monitoring Log Template

All audible sound sources observed by field personnel at each monitoring site will be summarized (see the example in the Table 5-1). The planned summary table includes A-weighted equivalent sound level (L_{Aeq}) and A-weighted L_{10}, L_{50}, and L_{90} Time Exceeded Levels for the measurement period. In addition, the loudest A-weighted one-second sound level (L_{max}) among all observed events will be provided for each location, along with the date and time window in which the L_{max} measurement was made.

Table 5-1. Example Summary of Audible Sound Sources and A-weighted Sound Levels at Each Monitoring Location

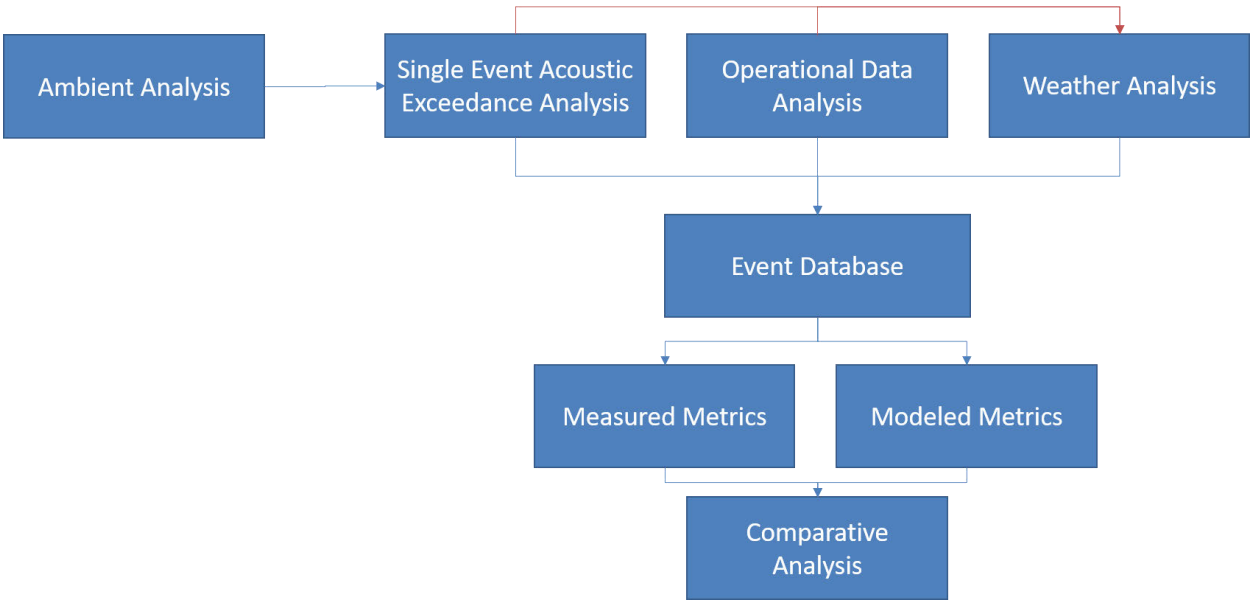
Location	Audible Sound Sources Observed	A-weighted Sound Level (dBA)					
		L_{Aeq}	L_{10}	L_{50}	L_{90}	L_{max}*	L_{max} Date/Time
Example: Maple and Elm St	Passing Vehicles Along Elm St, Aircraft, Commercial HVAC, Birds Chirping, Wind through Vegetation, Insects Chirping, Construction Activity, Pedestrians Talking, Music	58.6	55.1	51.8	47.8	81.7	March 15, 2021 1:28:05-25 PM

***Observed**

6 Overview of Analysis Steps

The sound level and spectral data collected from each site will be used to describe the overflights and ambient soundscapes measured at the monitoring locations. The following specific analyses will be performed:

- Quantifying the ambient sound levels occurring at the monitoring sites to provide context for the sound levels generated by flight activity.
- Identifying potential flyover events from acoustic characteristics such as level, duration, and frequency spectrum.
- Identifying time periods of potential flyover events at each monitoring site based on time of flight and sound propagation time.
- Documenting weather parameters corresponding to each flyover event.
- Documenting the sound characteristics of each flight identified in the observer data logs, including location, date, time, maximum sound level, duration of sound, and sound exposure level.
- Quantifying modeled sound metrics for observed flight activity for comparison with measured sound metrics.
- Summarizing the findings from the acoustical analysis.



6.1 Acoustic Analysis

6.1.1 Frequency Weighting

Sounds with different frequency spectra are perceived differently even if the sound levels are the same. Weighting curves have been developed to correspond to the sensitivity and perception of different frequencies of sound. A-weighting and C-weighting are the two most common frequency weightings.

These two curves, shown in Figure 6-1, are adequate to quantify most environmental sounds. A-weighting puts emphasis on the 1,000 to 4,000 Hz frequency range whereas C-weighting is flatter across the frequency range.

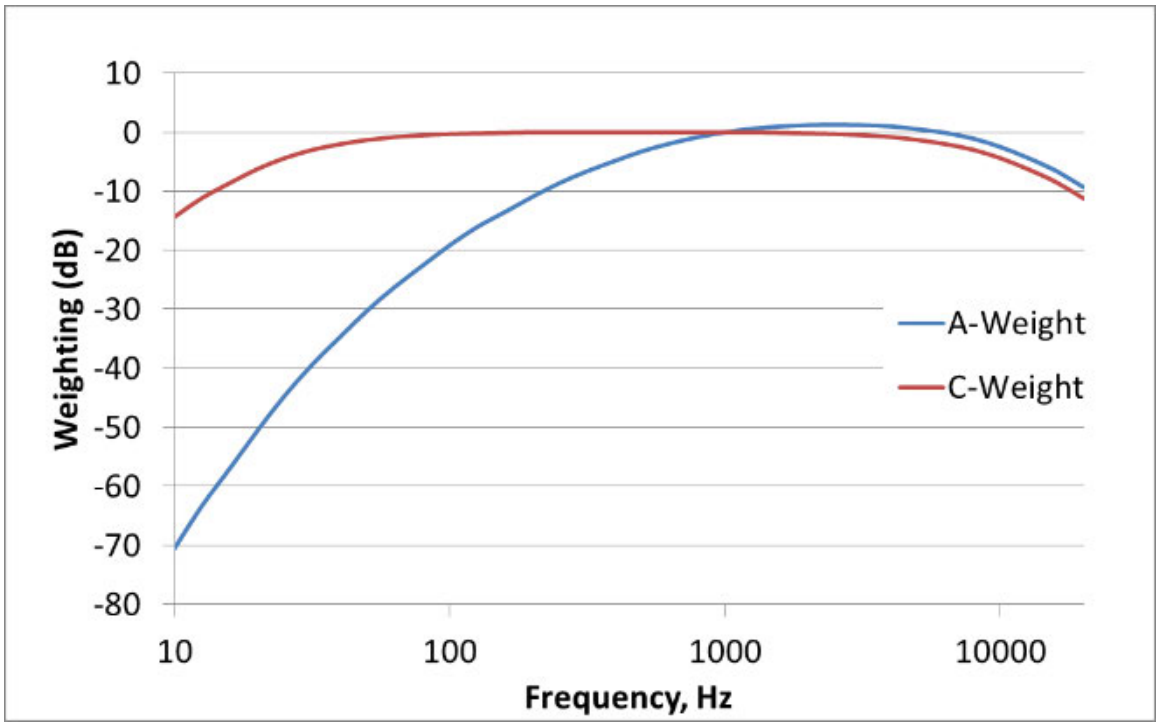


Figure 6-1. Frequency Curves for A and C Weightings

6.1.2 Aircraft Sound Metrics

A variety of acoustical metrics have been developed to describe sound events and to identify any potential impacts to receptors within the environment. These metrics are based on the nature of the event and who or what is affected by the sound. A brief description of the acoustical metrics that will be used in this monitoring study are provided in the following descriptions.

Equivalent Sound Level (L_{eq})

The Equivalent Sound Level is the sound level that represents the acoustical energy average of all sound exposures occurring with a defined period. The period of a L_{eq} measurement is typically provided along with the value (e.g. $L_{eq,1s}$ denotes a 1-second duration).

Maximum Sound Level (L_{max})

The maximum level occurring during a transient event is denoted as the Maximum Sound Level (L_{max}).

Sound Exposure Level (SEL)

SEL combines both the intensity of a sound and its duration. For an aircraft flyover, SEL includes the maximum and all lower noise levels produced as part of the overflight, together with how long each part lasts. SEL represents the total sound energy in the event. Because aircraft noise events last more than a few seconds, the SEL value is larger than L_{max}. SEL does not directly represent the sound level heard at any

given time during the event but rather during the entire event. SEL provides a much better measure of aircraft flyover noise exposure than L_{max} alone. Additionally, SEL is the basic metric used to calculate DNL.

Figure 6-2 provides an example of the relationship among the event-based metrics L_{max}, L_{eq}, and SEL. For a typical aircraft flyover event, the SEL will be great than the L_{max}, which will be greater than the L_{eq}. SEL is normalized to one second which accumulates all of the acoustical energy into one second, whereas the L_{eq} integrates the acoustical energy over the duration of the event, which is around 20 seconds for this example.

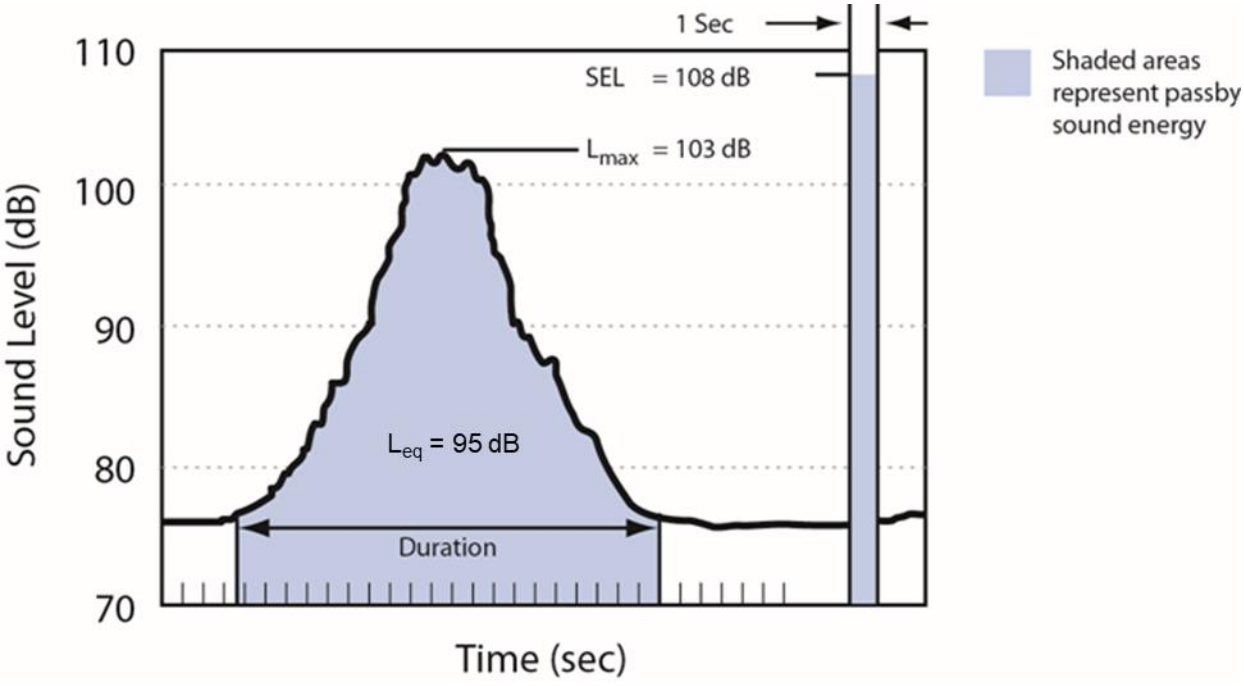


Figure 6-2. Relationship Among L_{max}, $L_{eq,20s}$, and SEL for Single Events

NN% Time Exceeded Level (L_{NN})

The NN% Time Exceeded Level is the sound level that is exceeded NN% of the time for a given period, such that for NN=99, the L_{99} represents the lowest level and for NN=01, the L_{01} is the highest level. The one-second sound level data measured for this noise study will be sorted to provide the range of sound levels that occurred on an L_{NN} basis. To best document the soundscape, various levels of the time-exceeded metric will be utilized. The L_{90} best describes the ambient soundscape.[(10),(11),(12)] This metric describes the background sound levels with minimal influence from noise intrusions. It is used for documenting the ambient soundscapes in natural and residential environments that are characterized by low sound levels. Sound Level Variation

Day Night Average Sound Level (DNL)

DNL is a cumulative metric that accounts for all noise events, such as aircraft operations, in a 24-hour period. However, unlike $L_{eq(24)}$, DNL contains a nighttime noise adjustment to account for humans' increased sensitivity to noise at night, DNL applies a 10 dB adjustment to noise events that occur during

the nighttime period, defined as 10:00 P.M. to 7:00 A.M. The notations DNL and L_{dn} are both used for Day-Night Average Sound Level and are equivalent.

Community Noise Equivalent Level (CNEL)

CNEL is a variation of DNL specified by law in California (California Code of Regulations Title 21, *Public Works*). CNEL has the 10 dB nighttime adjustment for noise events that occur between 10:00 P.M. and 7:00 A.M. but also includes a 4.8 dB adjustment for events occurring during the evening period of 7:00 P.M. to 10:00 P.M. This evening adjustment included in CNEL accounts for the added intrusiveness of sounds occurring during that period.

For airports and military airfields, DNL and CNEL represent the average sound level for an average annual day.

6.1.3 Acoustic Metric Calculation

After the acoustical data have been collected, quality checks will be performed before the analysis commences. Thereafter, the analysis will consist of calculating aircraft noise metrics at each monitoring site, to include: L_{Amax}, SEL, DNL or CNEL, Number of Events Above, and Event Durations. This initial process is the same for airfield and ONP SLMs. The only difference is the time periods (i.e. four weeks versus 365 days).

To provide a greater level of detail, composite spectra will be generated based on hourly, OTOB, and percent-exceedance levels. These composite spectra will include the mean value for the exceedance level for each OTOB for each hour of the day. The spectra will be calculated for the entire monitoring period and for each individual day, providing refined descriptions of the variation in the level and frequency content of the soundscape.

Following the observed activity tables with L_{max} values will be site-specific charts of the hourly variations in the measured sound level. The purpose of these charts is to provide a characterization of the sound levels occurring at each measurement location on an hourly basis, averaged over all monitoring days. Exceedance analysis will also be performed to identify prominent sound events of interest, like aircraft activity, that are occurring within the soundscape.

The one-second sound level data across all monitored days will be sorted to provide the range of sound levels that occurred within each hour of the day on an L_{NN} basis. The hourly sound level variation for each monitoring site will be provided on an L_{99}, L_{90}, L_{50}, L_{10}, and L_{01} basis in bar charts. Because the temporal resolution of the measurement data will be 1 second, L_{max} is appropriate for the shorter event durations found in the observation tables, and L_{01} is suitable for longer durations such as hourly data.

The SLMs at each measurement location will collect individual sound levels for the OTOB frequencies between 6 Hz and 20,000 Hz every one second. The overall sound level is a combination of the sound energies at each frequency.

The sound level variation at each monitoring location will be presented on a seasonal basis. The example chart below (Figure 6-3) shows four adjacent data blocks at eight monitoring sites corresponding to the seasons: autumn (red), winter (blue), spring (green), and summer (gold). The vertical extent of the colored blocks represents the middle 50% of measured sound levels, and the red intersecting line denotes the median level for that season. The dotted lines extending vertically from each block show the extent of the sound levels that includes two standard deviations from the median (two theta), or 95.5% of the data.

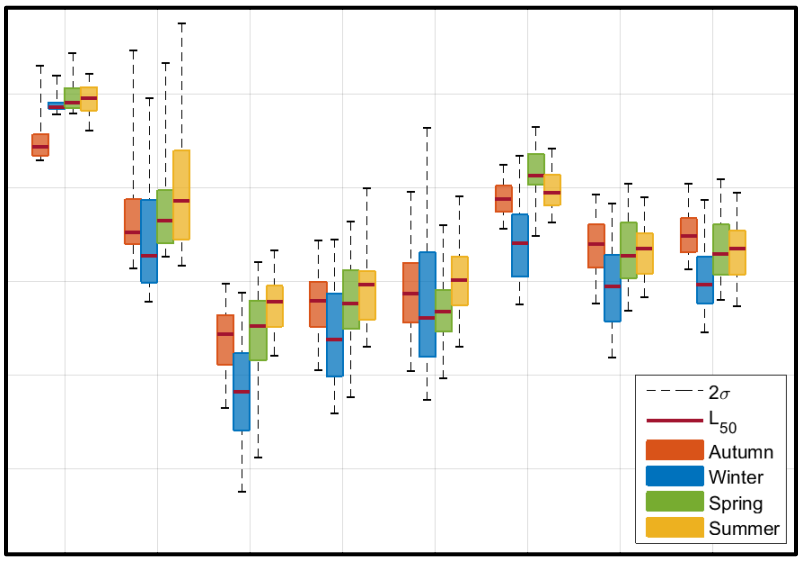


Figure 6-3. Example Seasonal Sound Level Variation for Eight Monitoring Sites (Y-Axis is $L_{eq,1s}$)

The pairing of the measurement data with the real-time operational data will align the two datasets. Although overflights may yield the highest L_{max} values at most monitoring sites, a range of overflight L_{max} values are expected in the monitoring data. This range will arise from variations in atmospheric conditions and individual flight paths.

6.2 Operational Data Analysis

6.2.1 Translate "As-flown" into Noise Model Input

During the seasonal monitoring periods for the airfields, real-time aircraft operations will be collected. The aircraft activity data will include flight paths, aircraft type, and runway usage. Based on the operational activity occurring during the monitoring periods, operational scenarios will be developed in the applicable noise models. Once the "as-flown" scenarios are developed, part of the evaluation of monitor and modeling data will involve the use of NoiseCheck procedures.[13] This procedure was developed by the Air Force Research laboratory to check the consistency between monitor and modeled data.

For ONP site, the operational data will indicate when the Olympic MOA was active with military aircraft. These active and non-active periods will be used to group the acoustical data for comparison between

these two periods as well as MRNMap modeled results for the Northwest Training and Testing Supplemental EIS/OEIS.[14]

6.2.2 Compare to Previously Modeled

As stated in the *Report to Congress:*

> To assess the accuracy of the DoD aircraft noise modeling tool, actual operational data for the daily, 7-day, and combined total time periods will be used to model aircraft sound. In addition, acoustic analysts will develop predicted noise metrics, including standard single event and cumulative noise metrics. These models and predictive metrics will then be compared to the real-time monitored noise data to determine alignment and variability between the two. The Navy intends to use a statistical analysis tool to calculate probability of consistency of the models to monitor noise data.

As further stated in the *Report to Congress: "*To determine if previously modeled noise contours from NEPA or AICUZ studies at NASWI and NASL accurately predicted noise levels, the Navy will statistically compare the models to the real-time monitored noise data. This will allow the Navy to determine if previously modeled contours are consistent with the real time noise data collected during periods of operational activity." This comparison will also utilize NoiseCheck procedures to evaluate the consistency between the monitor and previously modeled data.[4],[5] Hence, the analysis team will assess the agreement and variances between the monitored and modeled data.

For ONP site, the acoustical and operational data will be compared to the MRNMap modeled results for the Northwest Training and Testing Supplemental EIS/OEIS.[14]

7 Reporting

The *Report to Congress* states that:

> The Navy will submit a report to the congressional defense committees on the results of the monitoring study. The report will include: (1) the results of such monitoring; (2) a comparison of such monitoring with noise contours developed as a part of this effort and with previously developed noise modeling; and (3) an overview of any changes to the analysis and modeling process that have been made or are being considered as a result of the findings of such monitoring.

The acoustics team will provide a report to the Navy that documents the data collection procedures, the aircraft operational activity, and the measured average and variable acoustical data. The report will describe the noise modeling for the "as flown" operational activity and provide a comparison with the previous noise modeling cases. The operational differences between the "as-flown" and previous modeling will be identified and examined to explain the potential reasons for the differences. This examination of the operational difference will provide a framework to describe the differentials found between the modeling and measured sound levels.

The specific data deliverables will include digital files of the seasonal SLM maintenance logs and soundscape observer notes, as well as the seasonal measurement results and modeling files. The data will be categorized into directories and, to the extent possible, all data formats and provided information will be organized with consistent formatting. Further, a description of each of the monitoring locations will be provided, including a discussion of site-specific sound sources and observations taken during the monitoring period. Monitoring descriptions will include a detailed site location map and photos of the microphone position, as well as the measured variation in sound levels at the monitoring location.

The data files for each measurement site will include second-by-second sound levels on an overall and OTOB frequency basis. Additionally, the measurement results will be tabulated on an hourly basis to reflect the 99, 90, 50, 10, and 1 percentiles of sound levels at each monitoring site. Summary charts of the soundscapes will also be provided for context.

7.1 SLM Acoustic Data Organization

The datasets and graphical files developed for the monitoring report will be provided as follows:

1. L_{NN} Analysis
2. Exceedance Analysis
3. SLM Data

The L_{NN} Analysis (No. 1 above) will contain the following folder structure and content for all monitoring sites:

- L_{01}, L_{10}, L_{50}, L_{90}, L_{99}
    - Level – Hourly % Time Exceeded Covering a 24-Hour Period for Each Day and the Average

    - Spectra – OTOB Frequency Data Covering a 24-Hour Period for Each Day, the Average, and the Standard Deviation (STD)

- Summary
    - Level – Hourly % Time Exceeded Covering a 24-Hour Period, Averaged Over the Monitoring Period, for L_{01}, L_{10}, L_{50}, L_{90}, L_{99}
    - Spectra – OTOB Frequency Data Covering a 24-Hour Period for Each Day, Averaged Over the Monitoring Period, for L_{01}, L_{10}, L_{50}, L_{90}, L_{99}

The Exceedance Analysis (No. 2 above) will contain summary content for all monitoring sites, graphically showing the overall monitoring results.

The acoustic monitoring SLM Data (No. 3 above) will be downloaded from the individual SLMs and converted from the Larson Davis SLM files into more accessible MS Excel data files. The file names are standardized in the following format:

NASWI_XX_ID00X_202XXXXX.xlsx, where:

- NASWI – Designates “NAS Whidbey Island”
- XX – Identifies the Site Number
- ID00X – Specifies a Unique File Identification Number Per Site
- 202XXXXX – Identifies the Measurement Ending Date

For example, NASWI_03_ID005_20200926.xlsx would be an Excel data file containing the acoustic measurement data taken at Site 3 at NASWI, follows file ID004 in sequential time order, and would be downloaded on September 26, 2020.

8 References

(1) US Navy, "Report to Congress on Real-Time Aircraft Noise Monitoring Plan", 19 March 2020.

(2) National Defense Authorization Act, "Real-Time Sound-Monitoring at Navy Installations where Tactical Fighter Aircraft Operate", Fiscal Year 2020.

(3) American National Standards Institute/Acoustical Society of America (ANSI/ASA) S12.9 Part 2, "Quantities and Procedures for Description and Measurement of Environmental Sound. Part 2: Measurement of Long-term, Wide Area Sound", 2018.

(4) US Navy, "Final Environmental Impact Statement for U.S. Navy F-35C West Coast Homebasing," May 2014.

(5) US Navy, "Final Environmental Impact Statement for EA-18G 'Growler' Airfield Operations at Naval Air Station Whidbey Island Complex, WA", September 2018.

(6) US Navy, "Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement for Northwest Training and Testing; Appendix J: Airspace Noise Analysis for the Olympic Military Operations Area," August 2019.

(7) Larson Davis Inc., "Model 831C Sound Level Meter Reference Manual", I831C.01 Rev N. 2020.

(8) Larson Davis Inc., "NMS044 Noise Monitoring System Reference Manual", 2020.

(9) SAE Aerospace, "Monitoring Aircraft Noise and Operations in the Vicinity of Airports: System Description, Acquisition, and Operation," SAE Aerospace Recommended Practice SAE ARP4721 Part 1, Reaffirmed July 1012.

(10) Downing, J.M. and C.M. Hobbs, "The Soundscape in ZION National Park", Wyle Report, WR 03-08, March 2003.

(11) Plotkin, K.J., "Review of Technical Acoustical Issues Regarding Noise Measurements in National Parks", Wyle Report, WR 01-20, January 2002.

(12) Harris, C.M., "Handbook of Acoustical Measurements and Noise Control", 1998.

(13) Bishop, D.E., Harris, A.S., Rentz, P.E., and Mahoney, J., "NoiseCheck Procedures for Measuring Noise Exposure from Aircraft Operations," AFAMRL-TR-80-45, November 1980.

(14) US Navy, "Northwest Training and Testing Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement," Draft, March 2019.